



# Earth Monitoring Satellite System with Combined Infrared Interferometry and Photopolarimetry for Chemical and Biological (CB) Defense

The Infrared Earth Monitoring Satellite (IREMS) system is designed to alert against localized chemical or biological contamination on a surface, or in vapor and aerosol forms above the terrestrial or synthetic landscape, from low earth orbit. IREMS combines passive Fourier transform infrared (FTIR) spectrometry and active Mueller matrix infrared (MMIR) photopolarimetry as a unit fusion sensor, as it employs common photoelastic modulation (PEM) optics and a powerful CW tunable CO<sub>2</sub> laser system. The chemical contamination detection task is facilitated by FTIR measurement of the ambient object in field of view (FOV) of the telescope, while biological detection employs differential-absorption MMIR measurement of the backscattered laser radiance. The telescope part of the satellite incorporates a Schwarzschild objective that, together with a ZnSe corrector plate inserted through its primary mirror bore, produces highly collimated infrared light from the object FOV. That collimated infrared light is subsequently sent to FTIR interferometer or photopolarimeter optic configurations. The FTIR interferometer operates on the collected object radiance producing a temporal signal called an *interferogram* (a summation of constructive and destructive interferences in object ambient infrared light) that are later deconvolved into spectral composition of the imaged object over 7.14 -14.3 micrometer wavelengths: the mid IR fingerprint band of most CB materials.

Likewise, the photopolarimeter optics operates on the object radiance generating a waveform called *scattergram* (an encryption of the MMIR elements). The satellite design with common PEM embodiments can generate both interferograms and scattergrams in sequence. Following the interferometer or photopolarimeter, a 7-element ZnSe lens optic images the object onto a 460 x 460 pixels cryogenic MCT detector array covering a 2 x 2 mm<sup>2</sup> photoconductive surface area. This charge-coupled device (CCD) detector array is multiplexed to on-board fast FTIR interferometer and Mueller matrix processors, producing spectra and difference Mueller matrix elements from object FOVs, projected by each pixel element of the detector. These data are then preprocessed and distributed to neural networks (also on-board) programmed to pattern match pre-selected contaminants, and decide on their presence or non-presence.

Reference: Patent number 5,659,391, issued to the U. S. Army, August, 1997, A. H. Carrieri, inventor.

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